

H₂S Safety in the Oilfield

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What Do you Know about H₂S?

- What do YOU NEED TO KNOW???????
- Are you willing to gamble?????
- Often times we assume.
- This comes from lack of experience.
- Improper training.

What is Safety

- Any time that safety is involved it is an educated evaluation of risk and the desire and process of correcting or controlling the risk.
- This is where training and understanding are a key component.

Evaluations

- If we were posed with the following risks.
Most all of us would readily identify them and try to avoid or use some method of controlling or protecting ourselves from them.

Tornados



This is an easy one. The results!!!



The results from the tornado are devastating to one homeowner but the neighbor Has been fortunate and not been inflicted with near as much damage. This can work The same way in our industrial exposures.

Another very real hazard in our
working environments.



??????



The results of hazard



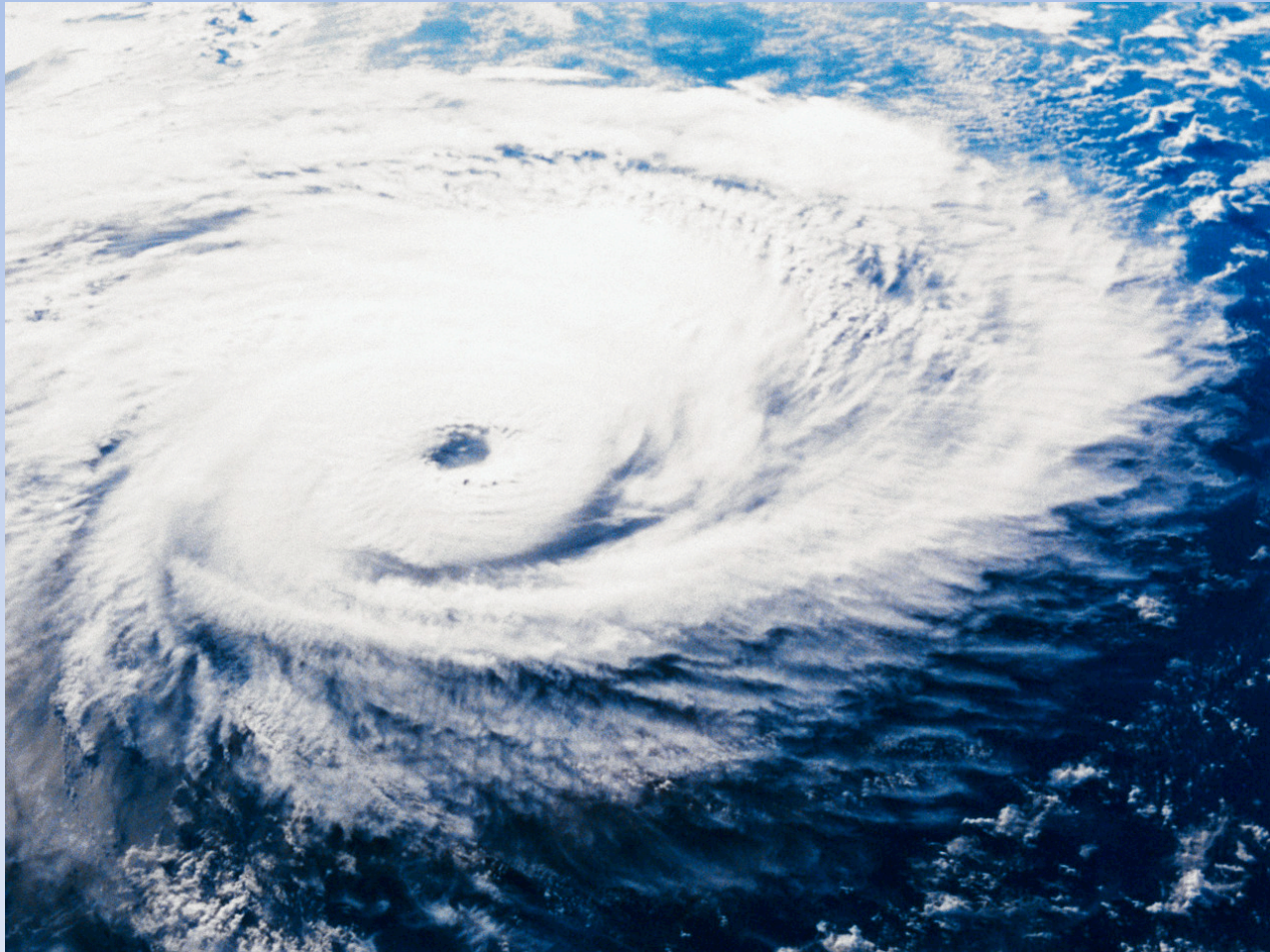
Severe Weather



Lightning results



Hurricanes



Hurricanes

- This is a hazard that fortunately gives those that might be affected much more notice and or warning.
- There still needs to be an evaluation that goes to a prepared plan to make ready and evacuate if need be.

Fire



Do you see the HAZARD here?

H_2S is INVISIBLE

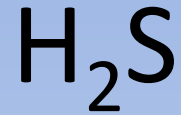


The results of an exposure of H₂S at
500ppm or greater

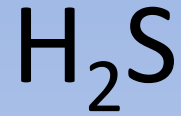


H₂S and you

- We protect ourselves in everything we do from education and training. Evaluation. We do it daily. When we wake, we look outside and evaluate how we will go about our day. What type of planning and PPE do we need to accomplish our needs for the day.
- Do we need to start early because of weather?
- Do we need a slicker or umbrella.
- What do we need to do to prepare ourselves
- H₂S is no different.



- H₂S is second in its dangerous exposure hazards only to Hydrogen Cyanide.
- It is colorless
- Odorless after a threshold has been hit to paralyze the olfactory nerves. This can be realized with a 100ppm (IDLH) Immediately dangerous to life and health exposure within 3-15 minutes.



- During the course of this presentation you will notice levels that are used in an approximate value.
- The physiological factor of the human body and how unique we all are will result in a difference in how each of us responds to exposure.

Physiological Factors

- Body Mass
- Overall physical condition
- Age
- Smoker/Non-smoker
- Also exposure, concentration and frequency of exposures and the duration of exposure.
- If alcohol, Rx meds or illicit drugs are present it may result in hypersensitivity. This being caused by multiple toxins that hit the liver via the bloodstream.

Other Variables

- Concentration of exposure
- Frequency of exposure
- Duration of exposure

Exposure Effects

- 10ppm- Obvious & unpleasant odor- eye irritation.
- 100ppm- Kills sense of smell in 3-5 minutes, may sting eyes and throat. Altered respiration, coughing and possible death within 48hrs.
- 200ppm- Kills sense of smell shortly. Stings eyes and throat, Respiratory irritation. Death with 1-2 hours of exposure.
- 500ppm- Dizziness, breathing ceases in a few minutes. Need prompt rescue breathing. Self rescue impossible due to loss of muscle control.

Exposure effects cont'd

- 700ppm- unconscious quickly, death will result if not rescued promptly.
- 1000ppm- unconscious at once. Followed by death in a few minutes.

Exposure

- ACUTE Short term, generally defined as exposure to high concentrations for short durations.
- CHRONIC Long term, generally defined as exposure to low concentrations for a longer duration.

Symptoms of Acute (short term-high concentration) exposure

- Olfactory paralysis
- Eye irritation
- Headache
- Nausea
- Dizziness
- Confusion staggering gait coughing
- Pulmonary edema
- Respiratory arrest brain damage
- Cardiac arrest

Symptoms of Chronic exposure (long term) low concentration

- Eye irritation
- Corneal blistering
- Headaches
- Nausea
- Irritation of respiratory tract
- Pulmonary edema
- Anorexia
- Sleep disturbances

Routes of Entry and Target Organs

- Injection bloodstream
- Ingestion Stomach, gastrointestinal tract
- bloodstream, liver
- Absorption bloodstream
- Inhalation respiratory system, bloodstream

Target Organs

- Hydrogen Sulfide H_2S is a toxic irritant gas whose major effects are exerted on the nervous system, the eyes and the respiratory tract. Other target organs affected are the brain and olfactory nerves.
- Olfactory Nerves loss of sense of smell occurs within 3-5 minutes at 100 ppm
- Brain headaches, nausea, dizziness, confusion, brain damage.

Target Organs cont'd

- Eyes irritation, tearing, inflammation, conjunctivitis, temporary loss of vision.
- Respiratory tract throat irritation, coughing, olfactory fatigue, pulmonary edema, respiratory arrest.
- Nervous system H_2S in the bloodstream reduces the oxygen-carrying capability of the blood which depresses the nervous system. Paralysis and respiratory arrest is usually followed within 5-10 minutes followed by cardiac arrest.

What is PPM

- PPM Parts per million is the equivalent of:
- 1 inch in 16 miles
- 1 minute in 2 years
- 1 cent in \$10,000.00
- 1 ounce of chips in 31 tons of chips

Those with risks

- Individuals with eye or respiratory tract problems are especially vulnerable.
- Individuals with anemia.
- Alcoholics or those that have consumed alcohol within 24hrs. Of exposure.
- Persons with psychiatric problems.

Exposure Limitations

- TLV (Threshold Limit Value) recently revised from 10ppm to 1ppm *****
- IDLH (Immediately Dangerous to Life & Health) 100ppm
- TWA (Time weighted average) safe level of exposure for an 8hr period 10ppm
- STEL (Short term exposure level) safe level of exposure for a 15 min period. 5ppm was 15ppm *****

Where can it be found?

- Drilling operations, recycled mud, produced water
- Tank gauging
- Confined Spaces pits, process vessels , frac and other tanks.
- Leaks in pumps and lines.
- Stripping of H₂S in refining
- Sulfur recovery

Where can it be found cont'd

- Injection of sour gas to stimulate production.
- Asphalt storage
- Acid Cleaning of wells and process units

Other types of locations

- Mines
- Volcanoes
- Geothermal Exploration
- Fishing industry
- Tanneries
- Municipal sewers
- Manure processing
- Breweries
- Slaughterhouses
- Landfills
- Feed lots
- Paper industry

H₂S Principle Hazards

- The principle hazard is death by inhalation. When the amount of gas absorbed into the bloodstream exceeds that which can be readily oxidized, systemic poisoning results with a general action to the nervous system. Death will occur with asphyxiation unless the exposed person is immediately removed to fresh air and breathing stimulated by rescue breathing.

H₂S Properties & Characteristics

- Forms a flammable and explosive environment between 4.3% and 46% in relativity of air.
- Is soluble in water and hydrocarbons
- Ignition temp. 500 degrees f
- Burns with a blue flame.
- Is heavier than air, vapor density 1.189 in comparison of air at 1.0

Common Names

- Rotten egg gas
- Stink damp
- Devils breath
- Sulfur gas

Training

- Training for employees working in or exposed to an H₂S environment can vary.
- Orientation- normally what is delivered on a rig or jobsite.
- Awareness
- Certificate- ANSI Z 390 recommendations are certificate level and normally a 3-4hr session to cover all recommended materials.

Additional Training Recommended

- Respirator awareness
- First-Aid/ CPR
- Confined Space

Work Procedures

- As in any work place the work procedure needs to start with a JSA (Job Safety Analysis)
- Discuss contingency plan, sensing devices onsite. Respiratory equipment and mustering as well as evacuation procedures.
- What condition is the site under? Green (possible danger) Yellow (10-50 ppm) Red (50 ppm or greater) Wear SCBA under condition RED or other supplied air respirator devices.

Work Place Control Recommendations

- The ANSI Z 390 was developed to supplement training requirements for OSHA 29 CFR 1910.1200 (Haz-Com) 1910.134 (Respiratory protection) and 1910.120 (Haz-Woper) standards. Section 1.3 of the Z390.1 reads . The standard is recommended for voluntary application in occupational settings where personnel have the potential to be exposed to concentrations of H₂S in excess of the TLV Threshold Limit Value (now 1ppm*) for chemical substances and Physical agents and Biological Exposure Indices (BEI) as established by the American Conference of Governmental Industrial Hygienists (ACGIH) .

Recommendations Cont'd

- It is also the recommendation of the Z390 that all individuals with the potential of exposure to H₂S be properly trained and supplied with adequate H₂S warning devices and appropriate respiratory protection.
- 29CFR 1910.134 no longer prohibits the wearing of contact lenses while using supplied air respirators.

H₂S Concentration in Eagle Ford Districts

| | Max PPM | Avg. Concentration |
|--------------|-----------|--------------------|
| • District 1 | 1,400,000 | 32,043 |
| • District 2 | 71,550 | 16,339 |
| • District 3 | 986,600 | 381,977 |

Work Procedures Cont'd

- In a letter from OSHA regional administrator from the Dallas Texas office, the answer to a question posed to them about tank gauging. The question was “how many stand-by personnel would be required for sour crude tank gauging?” answer, case by case basis but at least one. Factors such as access, how to transport if rescue were necessary etc.
- Stand-by person should be stationed outside IDLH atmosphere.

Work procedures cont'd

- Under condition RED all provisions of respiratory protection program must be followed.
- Clean shaven in respirator seal areas.
- Buddy system
- Only essential personnel in area. Have any other personnel leave location if able.

Work procedures cont'd

- Who should be trained on H₂S and what degree of training should they get.
- What measure of protection should a worker use in an atmosphere of 10ppm or greater?

Misconceptions

- Workers in the field, often times in the flow back and completion will assume that if there is an H_2S concentration at the sale line or on one end of the system that it is constant throughout the system. H_2S has the ability to concentrate, especially when becoming soluble with production waters etc. Truck drivers and gaugers are at particular risk at this point.

Misconceptions cont'd

- H_2S is heavier than air but is not always at ground level. It depends on origin of leak, pressure, volume and the dispersion factors mentioned earlier. H_2S can pool and or stack. If being moved by the wind it can be pushed against a berm, the brush surrounding the perimeter of the locations and actually stack and concentrate.

Monitoring Equipment

- Personal monitors.
- Should be worn in the breathing zone.
- Should be bump tested before each use.
- Calibrated and bump tested by manufacturer's specifications.
- Audible, flashing and vibrating alarms.
- Should be worn properly, in the breathing zone, not on boots or hard hats.

Personal Monitors



Fixed Sensors

- Audible, flashing alarms.
- Multiple locations on worksite.
- Normally have a high and low alarm level set
- Now reporting and warning systems to alert an office as well as emergency resources of an H₂S leak at a well or production location available as an add on.

Fixed Sensors cont'd



Respiratory Protection

- If working in an H₂S environment, respiratory protection must be used.
- A PFT (pulmonary function test) and medical evaluation must be done.
- Respirator awareness training and care for equipment must be done.
- Respirator should be SAR (supplied air respirator) and used in the pressure demand mode.
- No air purifying respirators > NO NO NO

SAR Respirator types

- SCBA – (self contained breathing apparatus)



SCBA's

- Portable, sufficient for rescue.
- Requires fit test, clean shaven at respirator seal area.
- Heavy
- No provisions for loss of air supply.
- Should be used in positive pressure supply.
- Rated at 30 minutes. Has 45 cubic feet of air. An employee on by demand will breathe up to 4.5 cubic feet a minute when under stress.

SAR Work units



Work Packs

- Light weight.
- Large volume of air supply.
- Escape pack provided.
- Restricted to 300ft of working line (hose)
- Tripping hazards

Escape Packs



Escape Packs

- Portable.
- No fit test needed.
- Not suitable for rescue attempts.
- Low volume of air (5 & 10 minutes)
- Issues from having plastic bag over head.

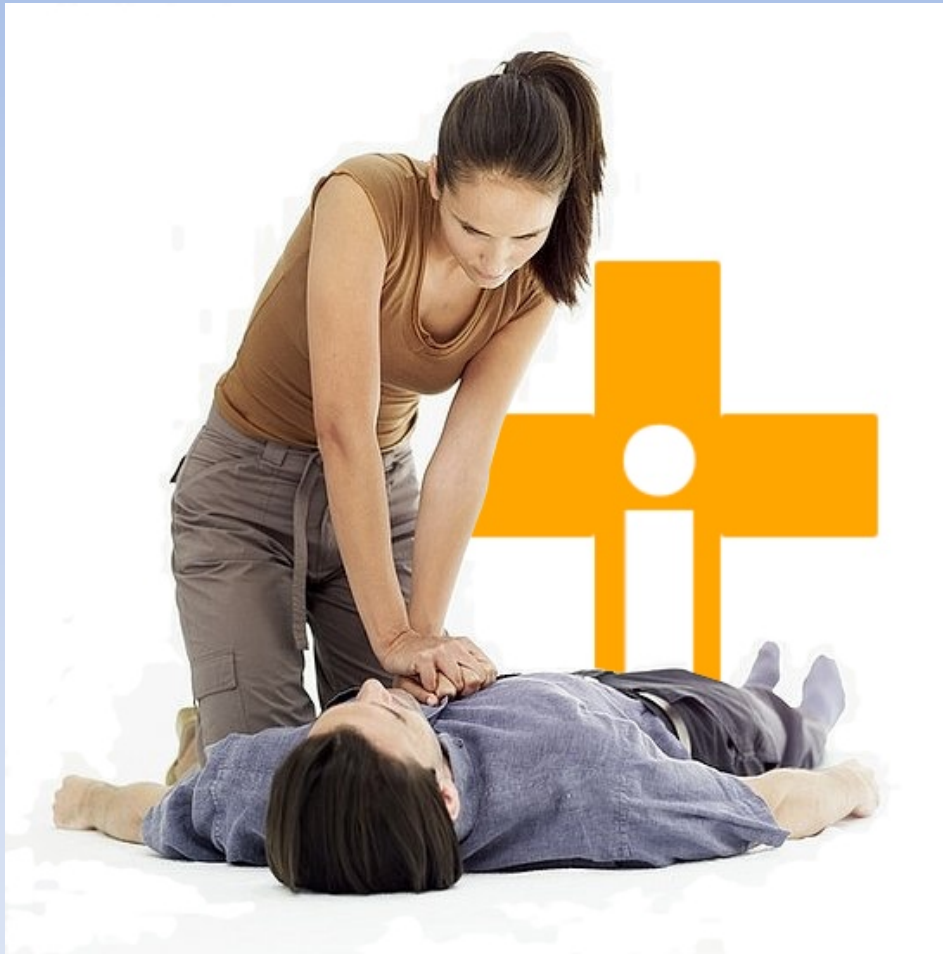
Testing Equipment

- Personal and 4 gas monitors
- Colorimetric tubes
- GC Gas Chromatograph
- Lead Acetate Strips

Medical Treatment

- Individuals must be removed to fresh air. If unconscious or not breathing CPR and rescue breathing immediately after clearing from affected area.
- Get professional medical treatment ASAP
- Even if an employee has not been “knocked down” by H₂S it is wise to seek medical attention because of risks of residual problems.

First-Aid



Dispersion of H₂S & Models

- A dispersion plan must be obtained on all drilling locations.
- Public proximity will be addressed and evacuation needs addressed.
- Zones of possible exposure within the model's area will be addressed by concentrations.
- Topography will be a factor.

Factors contributing to poor dispersion

- Calm winds (below 10mph)
- Stable air
- Cloudy skies, winter, nighttime.
- Low level inversion
- Fog
- Low temperatures (below 30 degrees F)
- High H₂S concentration, large volume and pressure.
- CO₂ present
- Low places, ravines, gullies.
- Buildings and other obstructions
- Trees

Factors contributing to good dispersion.

- Winds above 10 mph
- Unstable air, clear skies, summer , daytime
- No inversion
- No fog
- Temperatures over 90 degrees f
- Low H₂S concentrations, small volume, low pressure
- No CO₂ present
- Flat open ground
- No buildings or obstructions
- Grasslands

Flaring and Burning



Flaring cont'd

- H_2S achieves about an 80% burn rate.
- Flaring produces SO_2 (sulfur dioxide) which is toxic although not as toxic as H_2S .

SO₂ Properties and Effects

- Has a vapor density of 2.21
- Will seek out low places and pool, much like H₂S. Has the same dispersion characteristics
- 2ppm safe for 8hr exposure
- 12 ppm throat irritation coughing and constriction of the chest.
- 100ppm IDLH Immediately dangerous to life and health.
- 150ppm so irritating that can be endured for only a very few minutes
- 500ppm Causes a sense of suffocation, even with the first breath
- 1,000ppm Lethal concentration

Response

- Be aware of your contingency program and what part you play in it.
- Move to the muster area for directions and accountability
- Know who to call for response. Give them adequate warning of conditions and hazards.
- Only qualified and properly outfitted personnel should attempt rescue.
- Always be aware of wind direction and the coordinates of the location.
- If you are not part of the response evacuate if possible.

Case Histories

- Denver City Texas- H₂S began leaking in the early morning hours from a gas injection well 150 yards from a home. The H₂S leaking from the well mixed with carbon dioxide made a visible white cloud. When rescuers arrived they found the bodies of 8 people on the lawn. They died trying to make it to their vehicle. Across the street in another truck was the body of a 19 year old employee of the producing company.

Case Cont'd

- H_2S causes embrittlement or sulfide stress cracking. This was responsible for the wash nipple on the pressure indicator to fail
- Neighbors smelled the gas in time to get out to medical attention.

Detergent Suicide (H_2S)

- Created by mixing household detergents etc. at specific ratios.
- More than 500 in Japan in 2008
- Hazardous to responders who unknowingly would enter a vehicle or space the victim occupies.
- If you smell rotten eggs or find someone that appears to be sleeping in their vehicle look for a note and call police.

Suicide Cont'd

- Often times those choosing this method of suicide the victims have gotten the recipe off the internet and leave notes to warn those that find them or respond of the presence of the deadly gas.
- H_2S